Cleaning House—and Hive

A special line of bees uses the power of hygiene to fend off its worst foe

Among the small, hexagonal pockets of honeycomb that provide shelter to a bustling bee society, there's often another caste of tiny critters thriving just beneath the surface. But this invasive group—with its own intricate family structure—is one that any beekeeper would gladly do without.

The invaders are *Varroa* mites. And despite their slight stature (one mite is about the size of this lower case 'o'), the blood-sucking parasites can move in and take over a bee colony in just 2 years or less. They're currently the single largest threat to the bees U.S. growers need to produce countless flowering crops—from almonds and apples to onions and watermelons.

John Harbo, an ARS entomologist who studies the parasite, says, "*Varroa* mites have caused devastating losses to bee colonies, contributing to concerns over a bee shortage in the last year." Frustrating beekeepers' defensive measures is the mites' growing resistance to commercial pesticides.

But Harbo and fellow entomologist Jeffrey Harris, who work in ARS's Honey Bee Breeding, Genetics, and Physiology Research Unit at Baton Rouge, Louisiana, have found a natural, more lasting antidote to the mite problem: breeding genetically superior bees. They have specially selected bees with a "nose" for tracking down *Varroa* mites—and not just any *Varroa,* but those producing and rearing new generations of mites.

Mites in the Making

It's easy to dislike *Varroa*. Like most parasites, they're nimble, adaptive, and astonishingly resourceful. For example, when it comes time to raise their own offspring, the mites will raid honey bees' individual nurseries, or brood cells.

"When she's about to reproduce, a mother mite, known as a foundress," says Harbo, "will invade a brood cell containing a developing bee larva. To gain access to the cell, she'll ride the belly side of a nurse bee, which is onsite to tend to the bee larva. Then she'll crawl down to the bottom of the cell and immerse herself in food that was deposited for the immature bee."

While tucked safely inside the confines of the brood cell, the mother mite may produce as many as five daughters and one son, says Harbo. When they're old enough, they'll attach to the developing bee and feed on its blood. This may cause the immature bee, which is still vulnerable and soft, to develop malformations such as misshapen wings and legs.

When young bees reach the adult stage and are ready to exit the protective walls of the brood cells, they inadvertently release the mother mite and her now-mature daughters. The mites then seek out other adult bees to cling to and parasitize until they're ready to reproduce.

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An adult *Varroa* mite feeds on a developing bee.

While it's tedious work, Harbo and Harris have closely studied *Varroa* mites' reproductive cycle and activities. Harris has even gone so far as to glue flecks of craft glitter onto female mites to visually track their movements and fate within a bee colony.

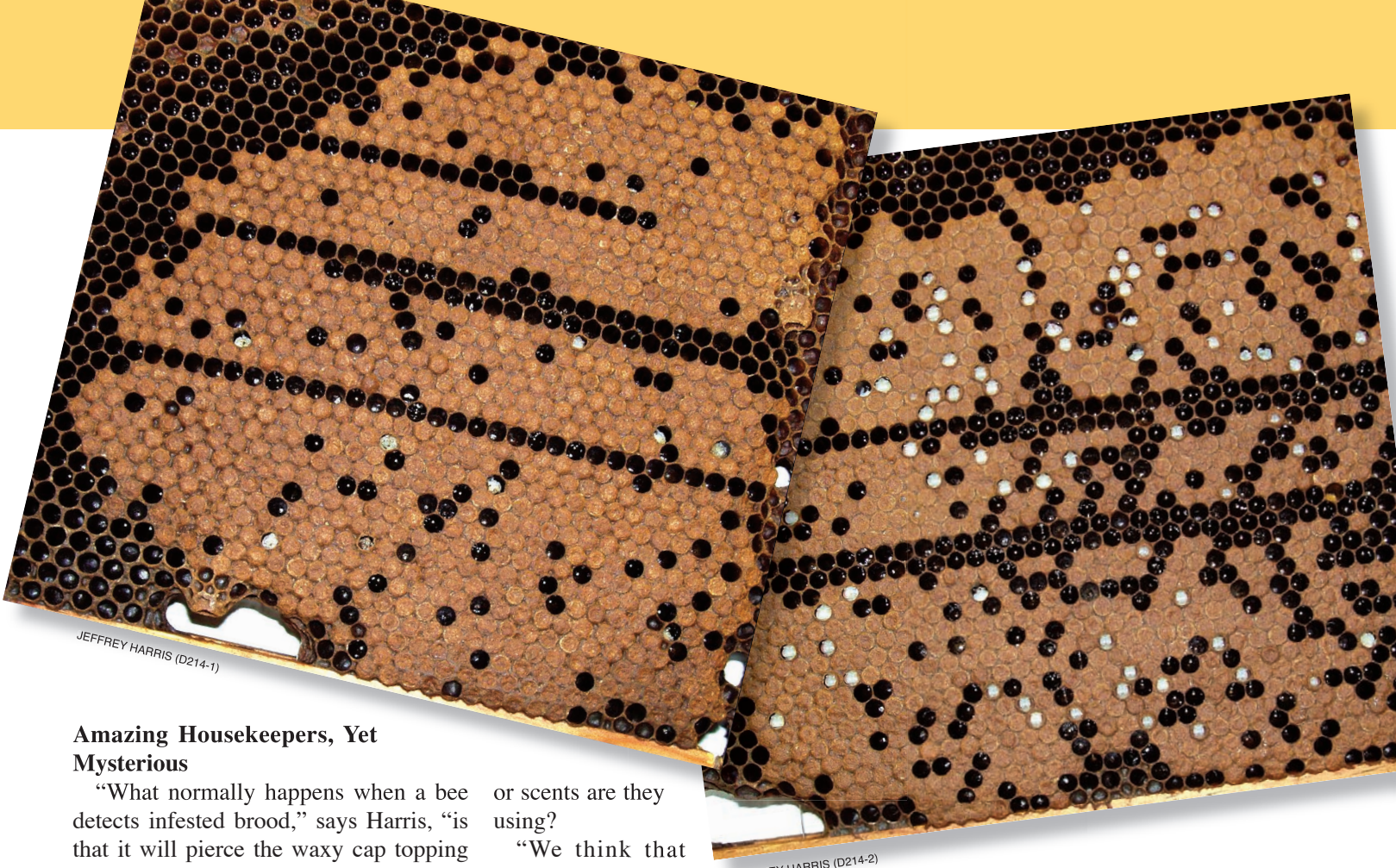
So the two were thrilled 9 years ago when they thought they'd discovered a trait in bees that could keep individual mites from reproducing.

They called this trait "SMR" for its apparent ability to suppress mite reproduction. (See "SMR—This Honey of a Trait Protects Bees From Deadly Mites," *Agricultural Research,* May 2004, p. 14.) When SMR bees were introduced into a colony, Harbo and Harris would watch numbers of mite offspring plummet.

The exact mechanism behind this intriguing trait remained unclear, but the researchers figured that a young SMR bee whose brood cell was infested with a female mite was somehow interrupting her attempts to reproduce—possibly through chemical cues.

Then a new explanation was offered by fellow bee researchers Marla Spivak and Abdullah Ibrahim at the University of Minnesota. Harbo and Harris tested their theory, and it turned out they were right. The SMR bees aren't altering the mites' reproductive habits or capabilities in any way. Instead, they're acting on hygienic impulses, selectively sniffing out and discarding brood cells infested by mites with offspring.

When Harbo and Harris couldn't find mite offspring in SMR colonies, they figured it had something to do with faulty mite reproduction—but it was, in fact, the SMR bees' keen ability to zero in on and remove young mites that was making all the difference.



JEFFREY HARRIS (D214-1)

JEFFREY HARRIS (D214-2)

Above: To demonstrate *Varroa*-sensitive hygiene by SMR bees, a highly infested brood comb was cut into halves, and each half was placed in a cage with 2,000 test bees for 24 hours. Control bees (left) removed only 12 pupae and uncapped another 19 pupae (33 percent of uncapped cells were infested with *Varroa* mites), while SMR bees (right) removed 215 pupae and uncapped another 178 pupae (90 percent of uncapped cells were infested with *Varroa* mites).

Amazing Housekeepers, Yet Mysterious

"What normally happens when a bee detects infested brood," says Harris, "is that it will pierce the waxy cap topping the cell, chew away at it, and then eat the parasitized bee."

This can have a range of consequences, none of which bode well for the mite. The mites' life cycle can be interrupted, the immature mites may die of starvation, or they may be eaten along with the mite-infested bee larva.

Often, two or more bees take part in this hygiene-related activity. "One bee will usually act as a detector, zeroing in on the sick, infested bee," Harris says. "Then a remover bee comes along to consume the contents of the cell, ridding the colony of potential contamination."

While the mite offspring are usually uprooted and destroyed in this process, the mother mites often survive. But through repeated interruptions to female mites' attempts to raise offspring, the fastidious, *Varroa*-sensitive bees are having a sure and steady impact. The bees keep new mites from being produced, and over time this constant interference whittles down the overall mite population.

But there's still some mystery surrounding Harbo and Harris' *Varroa*-specific bees. How are the bees able to home in on mites with families? What chemical cues or scents are they using?

"We think that they can smell the mite's offspring," says Harris. But there are other possibilities. "*Varroa* mites carry viruses and diseases," he says, "so bees infested by them could have a sickly smell."

Harbo and Harris hope to better explain the bees' impressive hygiene abilities down the road, but in the meantime they're upbeat about the insects' potential. It's likely that their bees are sensitive not only to the presence of *Varroa*, but also to other diseases or pests, leaving them even better positioned to defend embattled hives.—By **Erin Peabody,** ARS.

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